CLAIMS

We claim:

1. A microelectronic programmable structure comprising:

an insulating layer having a via formed therein;

an ion conductor comprising an oxide electrolyte and conductive material;

an oxidizable electrode proximate the ion conductor; and

an indifferent electrode proximate the ion conductor;

wherein at least one of the ion conductor, oxidizable electrode, and indifferent electrode is formed within at least a portion of the via.

2. The microelectronic programmable structure of claim 1, wherein the ion conductor comprises a material selected from the group consisting of GeO_2, As_2O_3, Ag_2O, $Cu_{(1,2)}O$, and $SiO_{(1,2)}$, WO_x.

3. The microelectronic programmable structure of claim 1, wherein the ion conductor comprises a material selected from the group consisting of $SiO_{(1,2)}$ and WO_x.

4 The microelectronic programmable structure of claim 1, wherein the oxidizable eletrode comprises a material selected from the group consisting of silver and copper.

5. The microelectronic programmable structure of claim 1, wherein the indifferent electrode comprises tungsten.

6. The microelectronic programmable structure of claim 5, wherein the ion conductor comprises tungsten oxide.

7. The microelectronic programmable structure of claim 1, further comprising a barrier layer between the oxidizable electrode and the indifferent electrode.

8. The microelectronic programmable structure of claim 1, wherein the ion conductor is interposed between the indifferent electrode and the oxidizable electrode.

9. A method of forming a programmable microelectronic device, the method comprising the steps of:

providing a substrate;

forming a first insulating layer overlying the substrate;

forming a second insulating layer overlying the first insulating layer;

forming a via within the second insulating layer;

filling the via with first electrode material;

removing any excess first electrode material;

forming an ion conductor overlying the first electrode material; and

forming a second electrode material overlying the ion conductor.

10. The method of claim 9, wherein the step of forming an ion conductor comprises exposing the first electrode material to an oxidizing atmosphere to form an oxide ion conductor.

11. The method of claim 9, wherein the step of forming a second electrode material comprises the steps of:

depositing a material comprising silver, copper, or a combination thereof; and

patterning the second electrode material.

12. The method of claim 9, wherein the step of forming the first electrode comprises damascene processing.

13. The method of claim 9, wherein the step of forming the second electrode comprises damascene processing.

14. The method of claim 9, further comprising the step of forming a metal layer underlying the second insulating layer.

15. The method of claim 9, wherein the step of forming an ion conductor comprises depositing ion conductor material overlying the first electrode.

16. The method of claim 9, further comprising the step of depositing contact material overlying the second electrode.

17. The method of claim 9, wherein the step of filling the via with first electrode material comprises depositing oxidizable electrode material.

18. The method of claim 9, wherein the step of filling the via with first electrode material comprises depositing indifferent electrode material.

19. The method of claim 9, wherein the step of forming an ion conductor comprises oxidizing the first electrode material at a temperature less than about 400 °C.

20. The method of claim 19, wherein the step of forming an ion conductor comprises using plasma-enhanced oxidation in an N_2O atmosphere.

21. The method of claim 9, wherein the step of forming an ion conductor comprises exposing the first electrode material to a wet chemical oxidation process.

22. The method of claim 21, wherein the step of forming an ion conductor comprises exposing the first electrode material to ultraviolet light at room temperature.

23. A method of forming a programmable microelectronic device, the method comprising the steps of:
providing a substrate;
forming a first insulating layer overlying the substrate;
forming a first electrode overlying the first insulating layer;
forming an ion conductor overlying the first electrode material;
forming a second insulating layer overlying the first insulating layer;
forming a via within the second insulating layer; and
filling at least a portion of the via with second electrode material.

24. The method of claim 23, wherein the step of forming the first electrode comprises deposition and etch processing.

25. The method of claim 23, wherein the step of forming the second electrode comprises damascene processing.

26. The method of claim 23, wherein the step of forming an ion conductor comprises exposing the first electrode to an oxidizing atmosphere to form an oxide ion conductor.

27. The method of claim 26, wherein the step of forming an ion conductor comprises oxidizing the first electrode material at a temperature less than about 400 °C.

28. The method of claim 27, wherein the step of forming an ion conductor comprises using plasma-enhanced oxidation in an N_2O atmosphere.

29. The method of claim 23, wherein the step of forming an ion conductor comprises exposing the first electrode material to a wet chemical oxidation process.

30. The method of claim 29, wherein the step of forming an ion conductor comprises exposing the first electrode material to ultraviolet light at room temperature.

31. The method of claim 23, wherein the step of forming the second electrode comprises depositing oxidizable electrode material.

32. The method of claim 23, wherein the step of forming the second electrode comprises depositing indifferent electrode material.

33. The method of claim 23, wherein the step of forming an ion conductor comprises depositing ion conductor material overlying the first electrode.